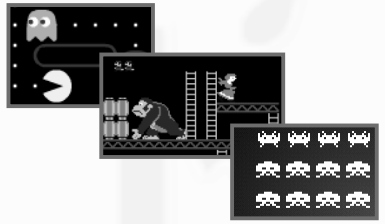
HY454 : *ΤΕΧΝΟΛΟΓΙΑ ΑΝΑΠΤΥΞΗΣ ΕΥΦΥΩΝ, ΚΙΝΗΤΩΝ ΚΑΙ ΠΟΛΥΜΕΣΙΚΩΝ ΔΙΕΠΑΦΩΝ*

ΠΑΝΕΠΙΣΤΗΜΙΟ ΚΡΗΤΗΣ,
ΣΧΟΛΗ ΘΕΤΙΚΩΝ ΕΠΙΣΤΗΜΩΝ,
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΥΠΟΛΟΓΙΣΤΩΝ

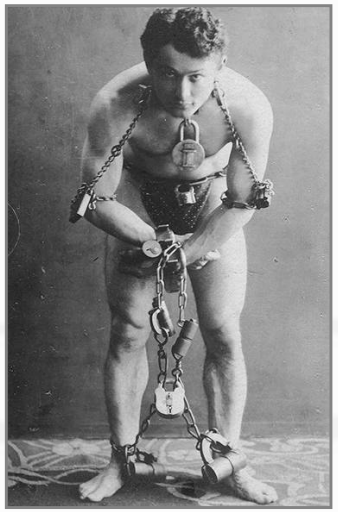
ΔΙΔΑΣΚΩΝ
Αντώνιος Σαββίδης



ΠΟΛΥΜΕΣΙΚΕΣ ΔΙΕΠΑΦΕΣ,
Σύνολο διαλέξεων 8, Διάλεξη 7η

D ffhvvlelow|#iqg#J dp hv

Universally Accessible Games (UA-Games)



Computer accessibility (1/2)

- Computer accessibility is traditionally associated with access to interactive computer-based systems by people with physical, sensory or mental disabilities
- However, there are several other user categories that confront substantial barriers that may prevent them from access to, and use of, such systems
  - Elderly people
    - aging very often results in limitations in vision, hearing, memory, or motor functions
  - People with situational disabilities
    - due to the environment they operate in
  - People with "technological disabilities"
    - due to the devices / software they use

Computer accessibility (2/2)

- In the past few years, the accessibility of electronic applications and services by elderly and disabled users has become a topic of paramount importance at an international level
  - Several governments and political bodies have adopted legislative and policy measures towards ensuring (or even enforcing) application software and Web accessibility
    - e.g. "Section 508" in the US, "eEurope 2005: An information society for all" in Europe

Computer games

- Beyond working and independent living, another basic need of most people is entertainment, and presently, computer games constitute indisputably one of the major related sources
  - The world-wide computer game industry is vast and comparable to that of books and music retail, the cinema box office, and VHS/DVD rental
  - Currently, there is a significant trend of employing games for training and learning (*game-based learning*)
    - University departments are gradually introducing computer games in their curricula to support alternative learning styles, attract student interest and help reinforcing learning objectives
  - Games are also promoted now as policy education, exploration, and management tools
    - e.g., the *Serious Games Initiative*

Computer games accessibility (1/2)

- Computer games are usually quite demanding in terms of motor, sensor and mental skills needed for interaction control, while they often require mastering inflexible, quite complicated, input devices and techniques
  - These facts often render games inaccessible to a large percentage of people with physical (or even situational) disabilities
- So far, little attention has been paid to the development of computer games that can be played by all players, independently of their personal characteristics, requirements or, (dis)abilities
- As long as it concerns HCI issues, computer games have fundamental differences from all the other types of software applications for which accessibility guidelines and solutions are already becoming widely available

Computer games accessibility (2/2)

- In contrast to Web accessibility, relatively few efforts have been devoted to game accessibility
  - Currently there are no related official guidelines or standards, nor any world-wide initiatives comparable to W3C-WAI, and evidently no related governmental or legislative actions
- Mainly a concern of groups of disabled people or of small companies producing related products
- The only related organized effort is the Game Accessibility Special Interest Group of the International Game Developers Association (IGDA) formed in 2003
  - aiming "to develop methods of making all game genres universally accessible to all, regardless of disability"

A definition by GA-SIG

- The Game Accessibility SIG defines game accessibility as:
  - "The ability to play a game even when functioning under limiting conditions.
    - Limiting conditions can be functional limitations, or disabilities - such as blindness, deafness, or mobility limitations."

in the White Paper: "Accessibility in Games: Motivations and Approaches"
http://www.igda.org/accessibility/IGDA_Accessibility_WhitePaper.pdf

Background

People with disabilities

- Worldwide, at least one person out of ten is disabled due to physical, mental or sensory impairments[1]
  - More than 500 million people worldwide
- Furthermore, there are around 600 million persons aged 60 years and over[2]
  - This number is estimated to double by the year 2025 and reach 2 billion by 2050
  - The number of "older" people playing computer games also increases
    - In 2003, 41% of most frequent game players were over 35 years old[3]

[1] United Nations, 2004. World Programme of Action Concerning Disabled Persons: Current situation. http://www.un.org/esa/socdev/enable/diswpa04.htm

[2] World Health Organisation, 2004. Department of Chronic Diseases and Health Promotion (CHP): About Ageing and Life Course. http://www.who.int/hpr/ageing/index.htm

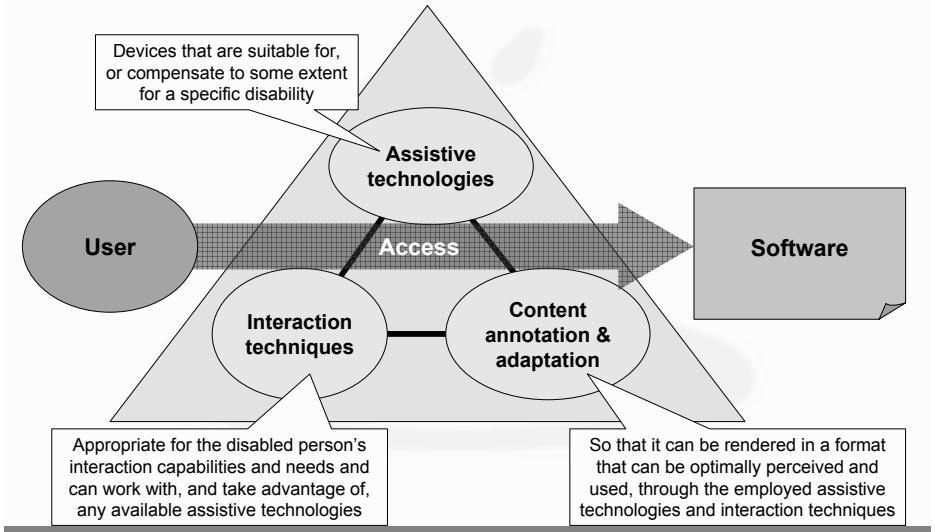
[3] Entertainment Software Association, 2003. Demographic Information. http://www.theesa.com/pressroom.html

Disabilities affecting computer accessibility

a. Visual impairments
b. Motor or dexterity impairments
c. Hearing disabilities
d. Cognitive disabilities
e. Speech impairments
f. Illiteracy

➡ Age-related disabilities are frequently referred to as a separate category, but all related problems fall within the above categories

Overview of Accessibility Solutions

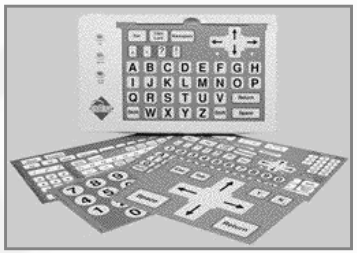


Indicative assistive technologies

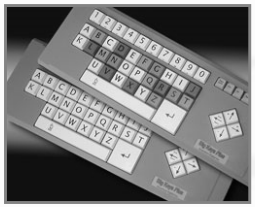
- Hardware
  - Special keyboards
  - Alternative mice, joysticks, trackballs
  - Switches
  - Braille displays
  - TTYs (teletypewriters)
  - Special game controllers
  - Trackers
  - Brain technologies
- Software
  - Screen magnifiers
  - Screen readers
  - Scanning software
  - On-screen keyboards
  - Alternative browsers
  - Speech input
  - Speech synthesis
  - Visual sound notification
  - Closed captioning

Special keyboards

Single finger or Head/Mouth stick keyboard (MALTRON)
http://www.maltron.com/



IntelliKeys (IntelliTools)
http://www.intellitools.com/



BigKeys (Gerystone digital Inc.)
http://bigkeys.com/

Twiddler 2 (Handkey corporation)
http://www.handykey.com/

Half Keyboard (Matias corporation)
http://halfkeyboard.com/

Alternative mice, joysticks, trackballs

Vertical Mouse (IntelliTools)
http://www.intellitools.com/

BigTrack (Infogrip Inc.)
http://www.infogrip.com

IntegraMouse (LifeTool)
http://www.lifetool.at/

Headway (Esterline Corporation)
http://assistive.traxsys.com/

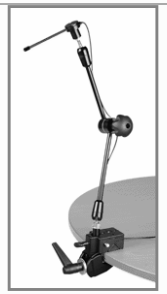
Perific Dual Mouse (Perific)
http://www.perific.com

SmartNAV EG (NaturalPoint)
http://www.naturalpoint.com/smartnav/

Switches

Big Red (Don Johnston Inc.)
http://www.donjohnston.com/

Mounting Switch (Don Johnston Inc.)
http://www.donjohnston.com/



Ribon switch (Tash)
http://www.tashinc.com/

Sensor Switch (Don Johnston Inc.)
http://www.donjohnston.com/

Scatir (infrared) (Tash)
http://www.tashinc.com/

Pneumatic (sip/puff) (Tash)
http://www.tashinc.com/

Brain technologies

Cyberlink (Brain Actuated Technologies, Inc.)
http://www.brainfingers.com

Special game controllers

Mouth Controller for Playstation® 2 Video Games (KY Enterprises)
http://www.quadcontrol.com/joystick.htm

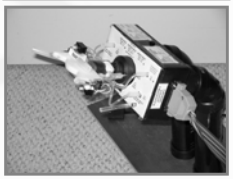
Team Xtreme for N64 (PDG, Inc.)
http://www.pathwaysdg.com/

Glove Controller for PS (Reality Quest)
http://www.teamps2.com/teamps2/Hard_Rev.php/292

Ascii Grip V2 Controller for PS
http://www.consolesandgadgets.com

Mouth Controller for Playstation® 2 Video Games (KY Enterprises)

- Mounts on a table or wheelchair
- Has one mouthpiece, which operates as a joystick
- Has 3 holes for "sip/puff" (6 switches) and 4 lip buttons
- "Start/select" is performed using a sip/puff switch mounted on the side of the mouthpiece
- Includes a toggle to designate whether the mouth-joystick is the "d" (digital) control
  - another toggle to designate the left or right analog control
  - lip switches for the L3 & R3
  - a toggle switch for turning on the microphone
- If the player has arm control, s/he can use an included modified PS2 game-pad in addition to the mouth-joystick to access all functions



Team Xtreme (PDG, Inc.)

- Allows a player with disabilities to team-up with another person, who assists using a standard game controller
  - Team Xtreme makes them look like one player to the game system
  - The player has full control over which aspects of the character s/he is controlling and which the team-mate is controlling
- A hardware box in which 1 to 5 switches can be plugged to control any keys of the game controller
  - A single switch can control 2 or more keys at the same time

Scanning software

- Scanning is a technique that is mainly used for providing computer access to people with hand-motor impairments
- The basic idea of scanning is that a special "marker" (e.g., a coloured frame) indicates the current focus
- The user can either move the focus marker or select whatever is in focus by using any kind of switches
  - e.g., keyboard keys, special switch hardware, voice
- In cases where the user can use just a single switch, focus movement can be automatically generated by the system at constant time intervals
  - This variation of the technique is usually referred as "automatic scanning", while any other case is generically called "manual scanning" (even if the hands are not used at all)

Scanning software example: ScanBuddy

- Emulates the mouse using 1 or 2 switches
- Supports alternative scanning strategies
  - standard line scanning
  - first use section scanning to identify the general area of the display where the target point is located and then use line scanning to precisely position the mouse

ScanBuddy
http://www.ahf-net.com/Scanbuddy.htm

On-screen keyboard

- Also called soft or software keyboard
- A keyboard that is presented on the monitor and replaces the hardware keyboard
- Keys are pressed by clicking on them with a mouse, tapping on them (on a touch screen) or using switch-based scanning
- On-screen keyboards are typically used to allow people with disabilities or special needs to use computers but also in public terminals (e.g., kiosks) and portable devices (PDAs) that do not have a hardware keyboard).
- The displayed keyboard can usually be moved and resized, and generally can allow any input that the hardware version does

On-screen keyboard example

- SwitchXS is a program for MAC that offers full mouse and keyboard emulation
- Provides a number of predefined scanning panels that the user can choose to move the cursor, click, and type into all standard Mac applications
- Features
  - audio-cueing
  - speech-cueing
  - key repeat, scanning speed and cycling
  - mouse speed and movement
  - the scanning panel can become partially or fully transparent when no scan is taking place

SwitchXS (AssistiveWare)
http://www.assistiveware.com/switchaccess.php

Closed captioning

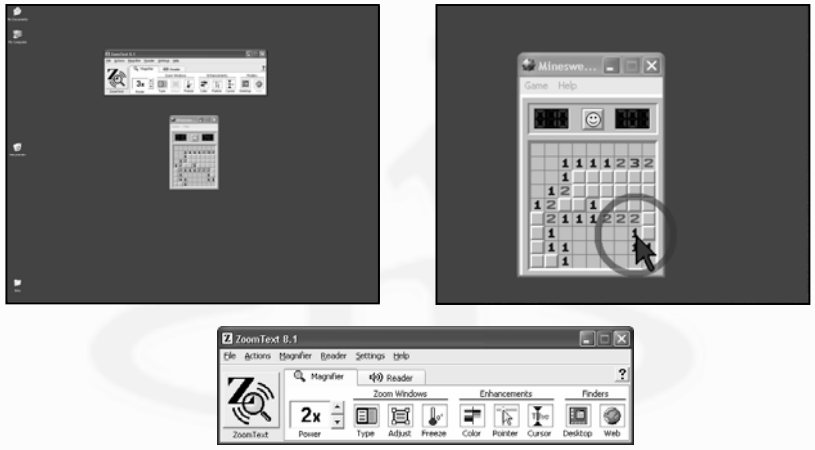
- Used by heard of hearing & non-native speakers
- Provides narrative description of dialogue, action, sounds, and other elements
- "Closed" means they can be turned on/off

DOOM3[CC]
http://gamescc.rbkdesign.com/

Screen magnifiers

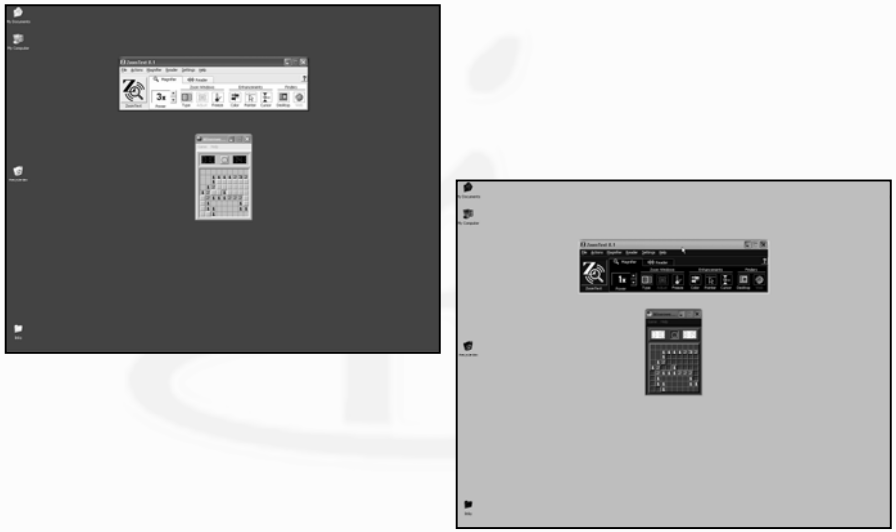
- Screen magnifiers are used by people with low vision
- They magnify the contents of the screen
  - Most such programs offer a maximum magnification to 16 times
- The entire screen can be seen by scrolling using the mouse or the keyboard
  - While moving the mouse the information on the screen changes
- Some programs can also:
  - Perform color enhancements to improve screen clarity for easier viewing and reduced eyestrain
  - Enhance the mouse pointer and cursor to make it easy to locate and follow them
- Sometimes they are coupled with a screen reader
  - echoes typing, reads information pointed to by the mouse, speaks program events

Screen magnifier example (1/2)



ZoomText (Ai Squared)
http://www.aisquared.com/

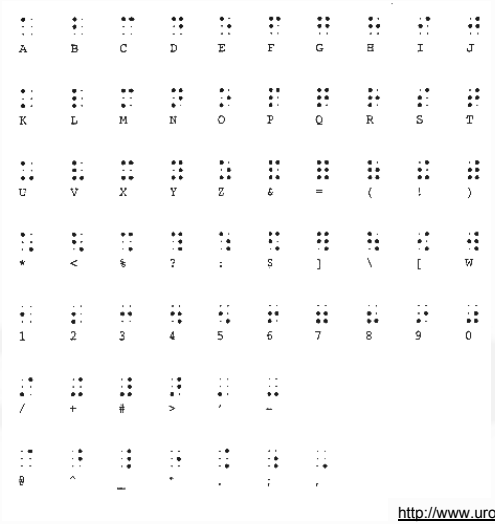
Screen magnifier example (2/2)



Braille

- Braille is a system using 6 to 8 raised dots in various patterns to represent letters and numbers that can be read by the fingertips
- Braille systems vary greatly around the world
- An 8-dot version of Braille has been developed to allow all ASCII characters to be represented

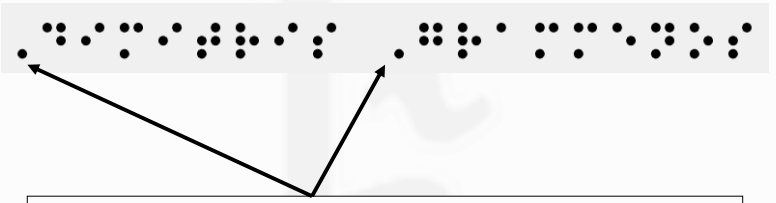
Braille ASCII Chart



http://www.uronramp.net/~lizgray/ascii.html

Braille example

D i m i t r i s G r a mm e n o s



the very first dot is a "capital sign" showing that the first letter of the name is capitalized

http://www.afb.org/braillebug/thenamegame.asp

Refreshable Braille displays

- Refreshable Braille displays provide tactile output of information represented on the computer screen
  - A Braille "cell" is composed of a series of dots
- Refreshable Braille displays mechanically lift small rounded plastic or metal pins as needed to form Braille characters

- Users read the Braille letters with their fingers, and after a line is read, they can refresh the display to read the next line

Refreshable Braille displays examples

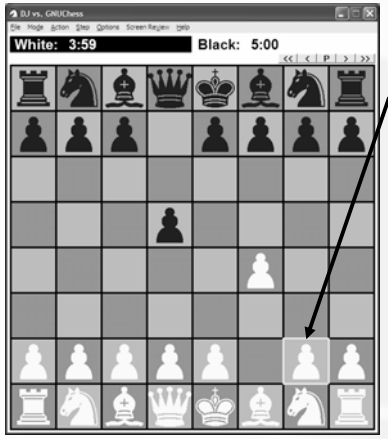
Refreshable Braille Displays (Focus)
http://www.synapseadaptive.com/focus/focus_refreshable_braille_displays.htm

Braille Wave (Handy Tech Elektronik GmbH)
http://www.handytech.de/1/no/43/147//40/b/s-index43.htm#Anker47

Screen reader

- A software program used by people with visual impairments
  - Uses synthetic speech to read a computer screen out loud
  - Some programs can also provide tactile feedback on a Braille display
- Using information made available by the application and / or the operating system, it can read text, and present the current focus, as well as interaction objects and their state
- Two popular screen reader programs are JAWS for Windows by Freedom Scientific (www.hj.com) and Window-Eyes from GW Micro (www.gwmicro.com)

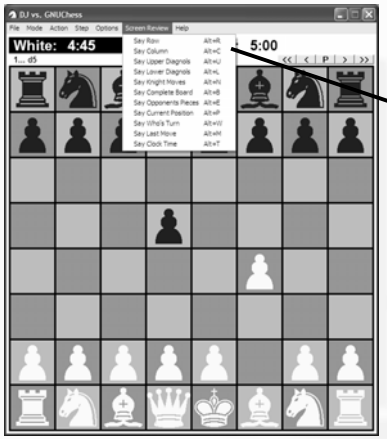
Screen reader example – WinBoard (1/2)



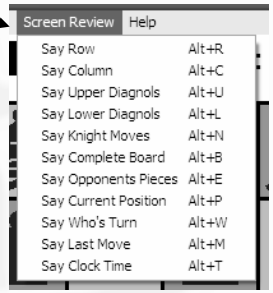
WinBoard for JAWS
ftp://ftp.freedomscientific.com/users/hj/winboard/WinBoard.exe

- Using the arrow keys the focus changes
  - Read aloud and / or rendered to Braille
- Space bar is used to select
  - Anything can be selected – illegal selections are announced
- Opponent's moves are announced
- Menu access using Alt & arrow keys or shortcuts

Screen reader example – WinBoard (2/2)



- Screen review options are offered through a menu

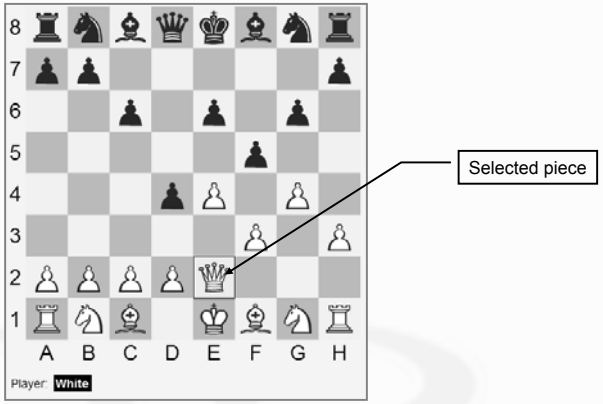


WinBoard for JAWS
ftp://ftp.freedomscientific.com/users/hj/winboard/WinBoard.exe

Quality of interaction

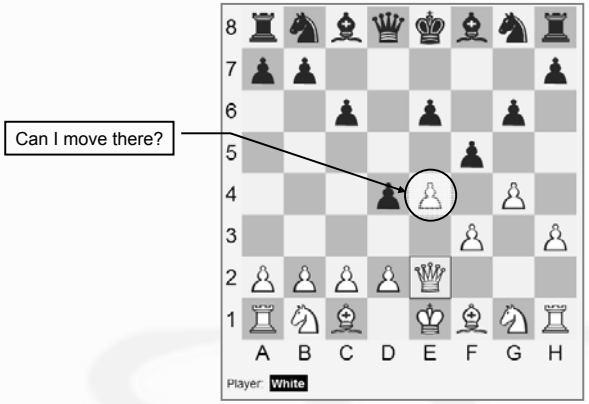
- Beyond providing accessibility an important issue, is quality of interaction
  - the extent to which the game meets the real world needs of its intended users and the support it provides to achieve their particular goals
- Requiring provision of access is not enough, especially in such an interaction-intensive domain as computer games

Quality of interaction example (1/5)



- A chess game can be made accessible to a blind person by simply providing an oral description of the entire board and of the currently selected piece

Quality of interaction example (2/5)



- This means that every time this person wants to access even some simple game-related information (e.g., find out if the selected piece can move to a specific square), will first have to listen to the description of every square on the board and then mentally isolate the desired piece of information

Quality of interaction example (3/5)

Simple accessible audio interface:

Selected piece: D2 white pawn

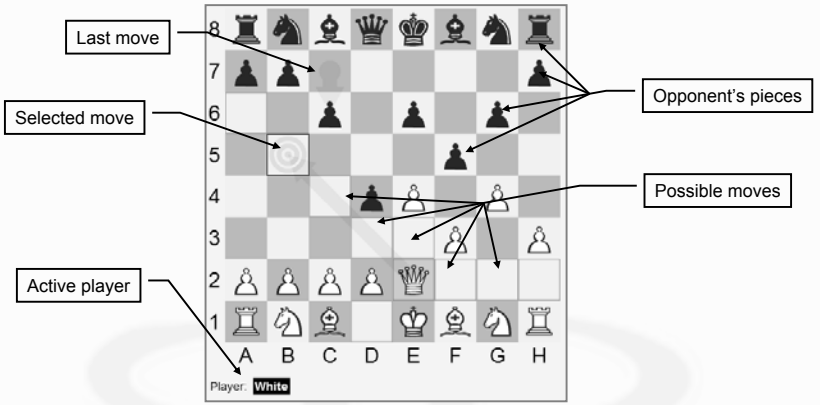
Board contents:

A1: White rook	F2: Empty	C4: Empty	H5: Empty	E7: Empty
B1: White knight	G2: Empty	D4: Black pawn	A6: Empty	F7: Empty
C1: White bishop	H2: Empty	E4: White pawn	B6: Empty	G7: Empty
D1: White queen	A3: Empty	F4: Empty	C6: Empty	H7: Black pawn
E1: White king	B3: Empty	G4: White pawn	D6: Empty	A8: Black rook
F1: White bishop	C3: Empty	H4: Empty	E6: Black pawn	B8: Black knight
G1: White rook	D3: Empty	A5: Empty	F6: Empty	C8: Black bishop
H1: White knight	E3: Empty	B5: Empty	G6: White pawn	D8: Black queen
A2: White pawn	F3: White pawn	C5: Empty	H6: Empty	E8: Black king
B2: White pawn	G3: Empty	D5: Empty	A7: Black pawn	F8: Black bishop
C2: White pawn	H3: White pawn	E5: Empty	B7: Black pawn	G8: Black knight
D2: White pawn	A4: Empty	F5: Empty	C7: Black pawn	H8: Black rook
E2: Empty	B4: Empty	G5: Black pawn	D7: Empty	

Quality of interaction example (4/5)

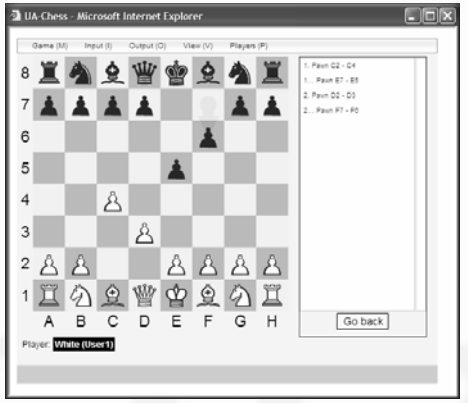
- Obviously, such an approach would create unnecessary high mental workload and very prolonged interaction times
- ➡ Thus, beyond simple access, the player should also be provided with augmented interaction capabilities that meet personal characteristics, needs and preferences

Quality of interaction example (5/5)



- The blind player should be able to quickly and easily access in a non-visual format any piece of game-related information that sighted players can infer just by looking at the visual interface

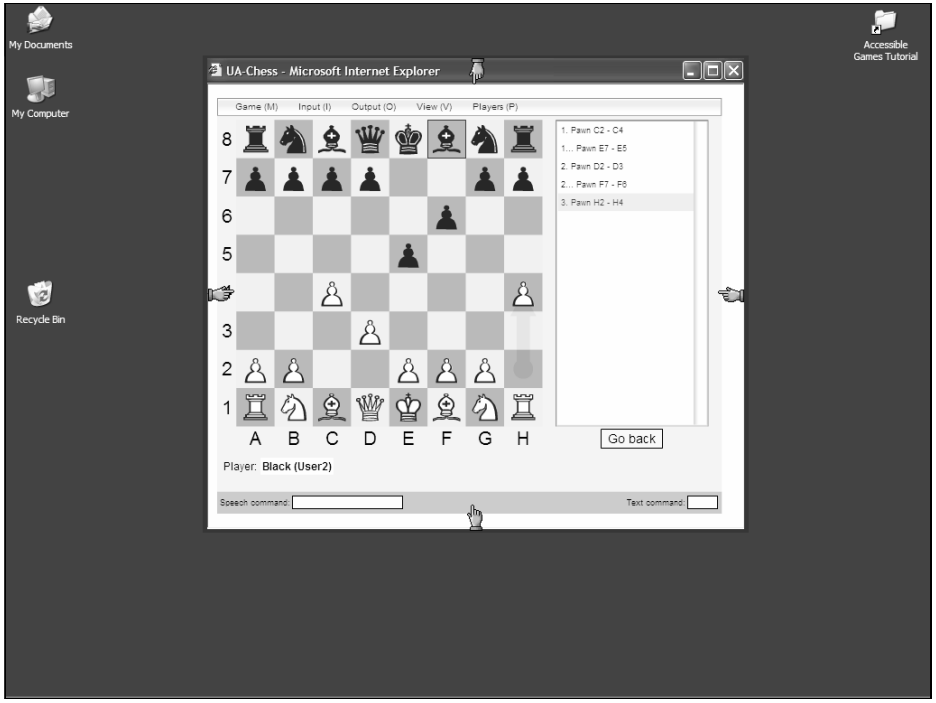
Quality of interaction example 2 (1/7)



- A chess game can be made accessible to a hand motor-impaired person through a switch-based mouse emulation program

Quality of interaction example 2 (2/7)

- This means that a lot of time and switch clicks will be required every time this person wants to select and move a piece (e.g., move pawn from H2 to H4)

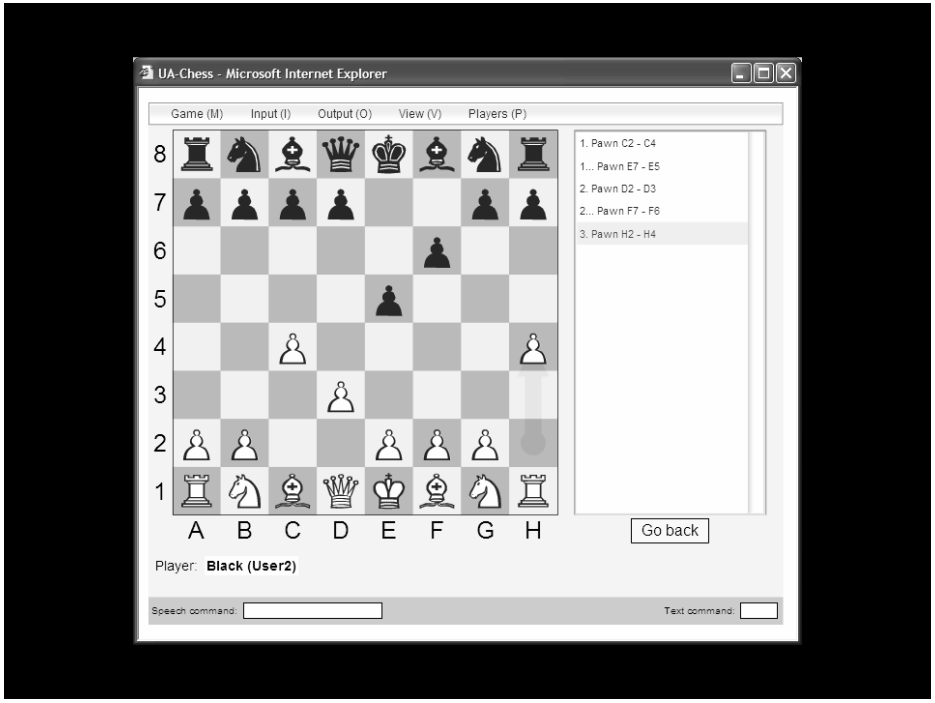


Quality of interaction example 2 (4/7)

- If no error is made in any click it would take
  - 16 clicks
  - ~35 seconds
- Furthermore, accessing the menus can be a real challenge since they take very limited screen estate and are quite hard to target
  - When a menu is selected, the scanning frame resets to the whole window
    - ✦There is no way to directly scan the menu's contents

Quality of interaction example 2 (5/7)

- Instead of using scanning for mouse emulation, it is embedded in the application
  - only the pieces that can move are scanned
    - ✦interaction becomes much more efficient



Quality of interaction example 2 (7/7)

- If no error is made in any click it takes
  - 3 clicks
  - ~15 seconds
    - using the same scanning speed as in the previous example

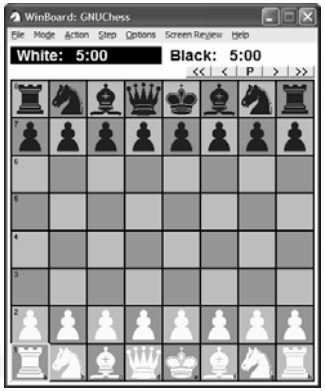
Approaches to Game Accessibility

Technical approaches to Game Accessibility

- From a technical point of view, two main approaches have emerged:
  1. Mainstream games are developed to be compatible with the use of assistive technologies
     - such as screen readers, mouse emulators or, virtual keyboards
  2. Special-purpose games are created, optimally designed for people with disabilities
     - like audio-based games for the blind and switch-based games for the motor-impaired

Example of the first approach (1/2)

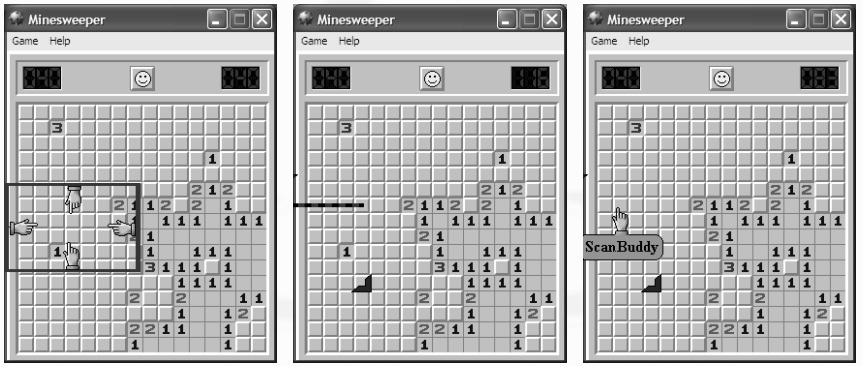
- **WinBoard**
  - A free graphical chessboard that can serve as a user interface for GNU Chess or the Internet Chess Server
    - ✦ can also be used to play out games manually or for loading game files
  - Fully keyboard-driven and adapted for compatibility with the JAWS for Windows screen-reader, through which it can offer several screen review options



ftp://ftp.freedomscientific.com/users/hj/winboard/WinBoard.exe

Example of the first approach (2/2)

- Any game that can be played by motor-impaired people using switch-based mouse emulator



First approach: Critique (1/3)

- Typically suffers from low interaction quality, and achieves limited accessibility
- Longer interaction times are required
  - because input and output are not optimised to fit the devices and techniques used
- Often only part of the full available functionality can be made accessible
- Error-prevention can not be supported and interaction can be particularly error-prone
  - e.g., when a mouse emulator is used selecting small areas can be very difficult

First approach: Critique (2/3)

- It is limited to reproducing the offered functionality, instead of redesigning it to suit the particular user needs
- Extensive configuration of physical interaction parameters is required in order to achieve usability
  - e.g., mapping between the assistive technologies used and the supported devices
- Impassable implementation barriers can arise
  - e.g., graphical images cannot be automatically reproduced in a non-visual form

First approach: Critique (3/3)

- Design conflicts may arise
  - e.g., having to reproduce drag & drop dialogue technique for blind players
- Upward compatibility is not offered
  - when a new version of a game is developed, the accessibility adjustments will have to be reimplemented

Examples of the second approach (1/2)

- Jetstream Trader by Brillsoft
  - Single-switch game
  - The player controls a hot air balloon
  - By pressing the switch the balloon goes up
  - Its direction is controlled by entering different 'jetstreams'
- The game is quite simple and consists of delivering cargo from one end of the screen to the other

http://www.brillsoft.com/Index_files/Page552.htm

Examples of the second approach (2/2)

- Super tennis by VIPGAMESZONE
- You use the enter key to serve the ball
- When the ball is coming towards you, you must pan it to the centre of the screen using left and right arrow keys
  - Using down arrow key + left or right speeds up movement
- To know were you are on the game field there is a left side, right side and a middle of the game field sound
- If the ball is right in front of you, you can return it
  - Left ctrl key returns the ball from the left to the right
  - Right ctrl key returns the ball from the right to the left
  - Space bar returns the ball right back
- Additional game info that can be accessed includes
  - the current score in the current game / match / set
  - set number, current game number and current serve
  - spoken help

http://www.vipgameszone.com/supertennis/suptennis.php

Second approach: Critique

- Though being the most promising from the quality point of view, has two key drawbacks:
  - (a) the cost of developing high quality games is prohibitive when the potential target group is limited
  - (b) there is an evident hazard of segregation between able and disabled gamers, leading to potential social exclusion

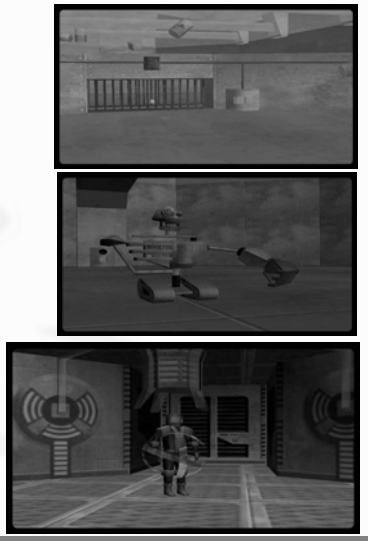
A more recent trend

- The development of games for both visually-impaired and fully sighted users
- Games that can be played both with or without graphics
- In some cases, some additional functionality is offered to non-visual players
  - e.g., sound-based navigation systems, full audio descriptions of scenes

A single player game for sighted & blind

- Terraformers by Pin Interactive
  - A visual / audio hybrid 3D game that can be played with its visual 3D graphics layer on or off
  - It is intended to support players at all degrees of visual ability or impairment with a sophisticated sound interface
  - Won the "Innovation in Audio Award" at the GDC Independent Games Festival 2003

http://www.terraformers.nu



Terraformers (Pin Interactive): Accessibility features (1/2)

- The accessibility features are provided through a self-voiced PDA built-in the player's suit
  - Sound Compass
    - a 3D sound represents north, and a rough 8 direction spoken feedback is available by pressing a key on the numerical keyboard (north, northwest...).
  - Sonar
    - a 3D sound gives the gamer a rough perception of the distance to objects in the direction the gamer is currently facing
    - by pressing a key, the gamer can also check what type of object it is (door, wall, robot...)
    - enemies are automatically told by the PDA voice
  - GPS
    - a global positioning system is used to get the exact positions of objects in an area, as well as the position of the player
    - a voiced menu system provides an overview of nearby objects

Terraformers (Pin Interactive): Accessibility features (2/2)

- Direct orientation
  - using the numeric keyboard, the gamer can orient the avatar directly in 8 directions (north, northeast...).
- Game objects
  - all game objects have voiced feedback and 3D sound icons
- Environments
  - 3D graphics, ambients sounds, footstep sounds on different ground materials and voiced descriptions of visual, as well as other sensory input, contribute to environmental feedback

A multiplayer game for sighted & blind

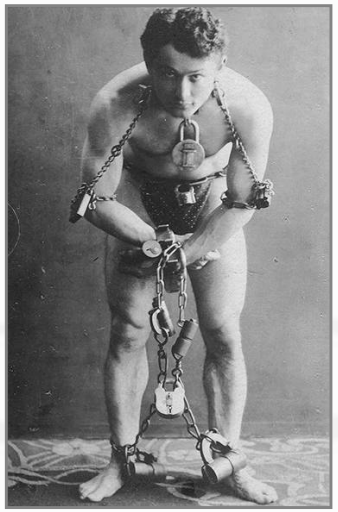
- *All inPlay*
  - Online multiplayer card games that can be played by blind, low vision, and fully sighted
- Supported features
  - Text-to-speech "reads" every move
  - Special sound effects alert for several events
  - Support of keyboard operation
  - The window can be resized and its contents also work with screen magnifiers

http://allinplay.com/

Requirements towards a novel approach

- Games should be inherently accessible to all the potential user groups
  - without the need of further adjustments, or third-party assistive software applications
- The same game should be concurrently accessible and playable, cooperatively or competitively, by people with diverse abilities

Universally Accessible Games (UA-Games)



Universally Accessible Games

- Follow the principles of Design for All
  - being proactively designed to optimally fit and adapt to different individual gamer characteristics without the need of further adjustments or developments
- Can be concurrently played among people with different abilities
  - ideally also when sharing the same computer
- Can be played on alternative technological platforms and contexts of use
  - using a large variety of devices, including assistive technology add-ons

Universally Accessible Games: Vision

- Through such games people will be able to have fun and compete on an equal basis
- ➡ while interacting easily and effectively
- ◆ irrespective of:
  - their individual characteristics
  - the technology they use
  - where they are

Universally Accessible Games: Impact

- They open up and enhance an entertaining social experience that would otherwise be unavailable to a significant percentage of people
- They allow for social interaction among people who may never have (or even could have) interacted with each other
- They considerably expand the size and composition of the potential market of the computer games industry

About Games & Fun

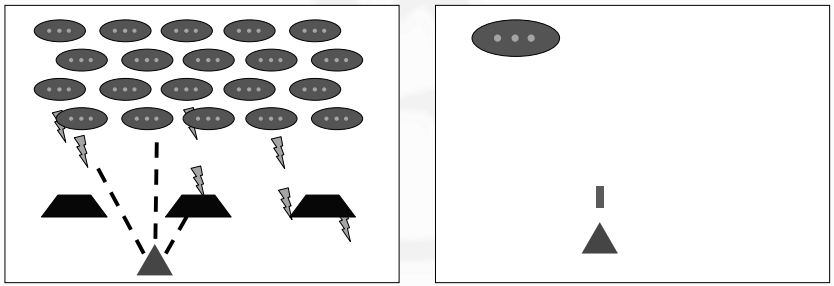
- People play games to have fun
- But what is fun?
  - "what provides amusement or enjoyment"
    - ✦ www.webster.com
- The important thing about having fun is that it is highly subjective
  - Some people may find the game of solitaire fun, while others may have fun blasting hordes of gun-packed aliens

About Games & Challenge

- Each and every game has one or more challenges
  - They may be mental, physical, or both
  - They can range from trivial to impossible, but this is usually were fun comes from
    - ✦ Beating the clock, gaining money, capturing the flag, shooting all the aliens, eating the dots, …
- As in the case of fun, what constitutes a challenge is also highly subjective
- ➡ When designing a UA-game, you should keep in mind that alternative levels (and types) of challenge should be supported

Diversity in game challenge

- Different people may have a different view on what is a challenging game



A note on UA-Games

- Every part of the game – not just the gameplay – must be accessible, using the same interaction methods and devices as the game
  - including selection screens, options and any additional functionality (e.g., pause, chat)

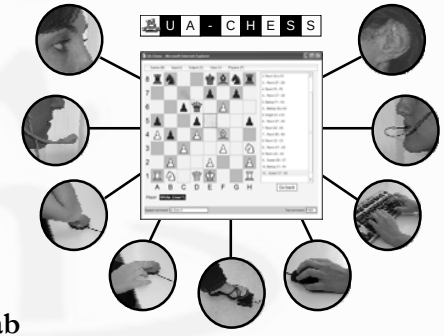
Case Studies

Board games

- Board games constitute a very fertile ground for developing UA-Games, due to the following reasons:
  - They have a small set of rules, which are simple, while not simplistic, and easy to learn, understand, and memorize
  - They are based on thinking, not on reflex-based reacting, a fact that can compensate for physical disabilities and allows for longer interaction times
  - They are played in a well-defined, physically constrained, static game world that allows to be rendered through alternative modalities
  - They usually also exist in a physical form, implying that people can also "physically" experience them
  - They are turn-based and thus, when incarnated in an electronic format, they can fully adapt to the active player's profile

UA-Chess

- Fully-functional chess game
- Can be played through a standard Web browser
- Can be concurrently played by people with different abilities and preferences, including people with disabilities
  - e.g., low-vision, blind and hand-motor impaired
- Developed by the HCI Lab of ICS-FORTH



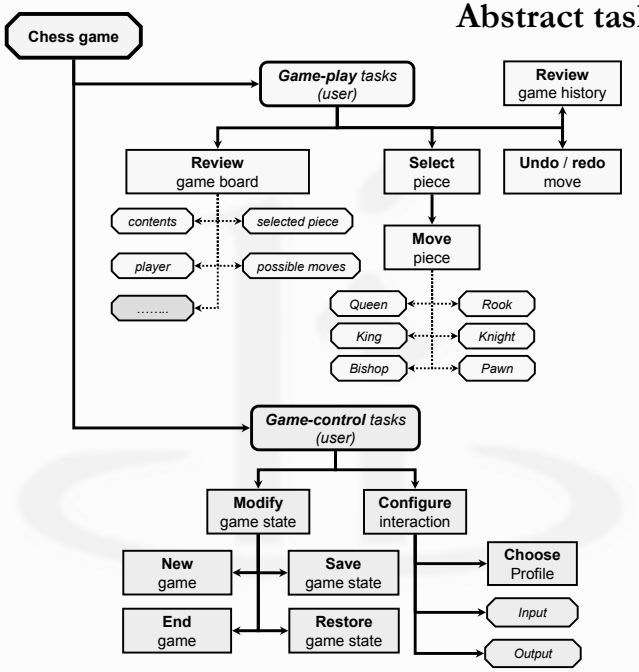
Interacting with UA-Chess

- Alternative input / output modalities & interaction techniques
  - that can co-exist and co-operate in the game's user interface
- Customizable player profiles
- Fully accessible through:
  - the mouse
  - the keyboard
    - ✦ or any type of switches emulating keystrokes
  - speech recognition
- Self-voicing capabilities
  - built-in screen reader that offers full auditory access to every part of the game
- Can be sized and zoomed in and out at different levels

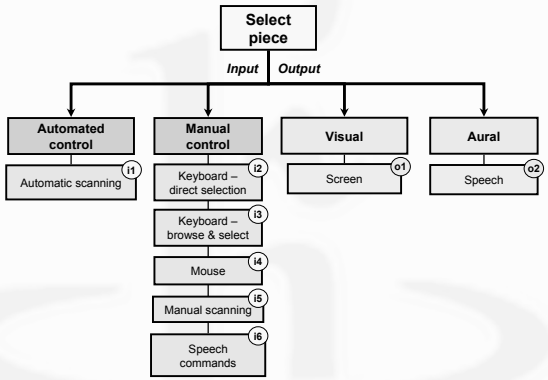
Designing UA-Chess

- Unified Design method
  1. Abstract task analysis
  2. Mapping of abstract design elements to low-level, physical, interaction styles, meeting the requirements of each target user group
     - Styles appropriateness matrix
     - Compatibility matrix

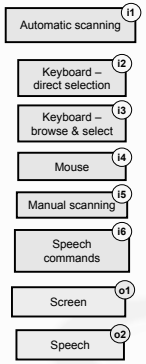
Abstract task analysis



Mapping abstract tasks to interaction styles



Interaction styles appropriateness matrix



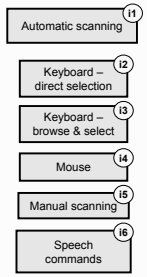
User attributes	Interaction styles: i1	i2	i3	i4	i5	i6	o1	o2
Full vision	=	=	=	=	=	=	✓	
Low vision						✓		✓
Blind			✓			✓		✓
No hand-motor impairment		✓		✓		✓	=	=
Uses multiple switches					✓	✓	=	
Uses single switch	✓					✓	=	
Mild cognitive impairment								
Expert		✓				✓	=	
Novice				✓			✓	✓

✓: ideal : appropriate : could be used : inappropriate = : neutral

✓ (*ideal*): Explicitly designed for this user attribute
Ç (*appropriate*): Suitable, but maybe not the best
È (*could be used*): If nothing else is available it can be used, though not recommended
r (*inappropriate*): Totally inappropriate, will result in an accessibility barrier
= (*neutral*): Does not have any effect on the particular user attribute

User attributes	Interaction styles: i1	i2	i3	i4	i5	i6	o1	o2
Low vision, novice, single-switch								

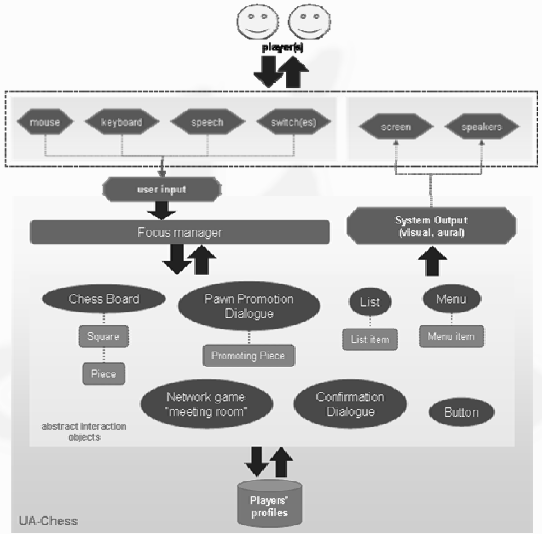
Compatibility matrix



	i1	i2	i3	i4	i5	i6
i1		✓		✓		✓
i2	✓		✓	✓	✓	✓
i3		✓		✓		✓
i4	✓	✓	✓		✓	✓
i5		✓		✓		✓
i6	✓	✓	✓	✓	✓	

✓: compatible : incompatible

Architecture



Technical info

- Developed using Macromedia Flash MX Professional 7
- On-line games using Macromedia Flash Communication Server MX 1.5

➡ Flash does not support speech input / output

- SALT (Speech Application Language Tags) was used (http://www.saltforum.org)
  - ✦ an emergent standard for developing voice-enabled applications for the Web that extends existing markup languages, such as HTML and XHTML

DfA Award

- Nominated for the final jury decision of the European Design for All Awards set by the European Commission
  - in the category "AT/Culture, Leisure and Sport"

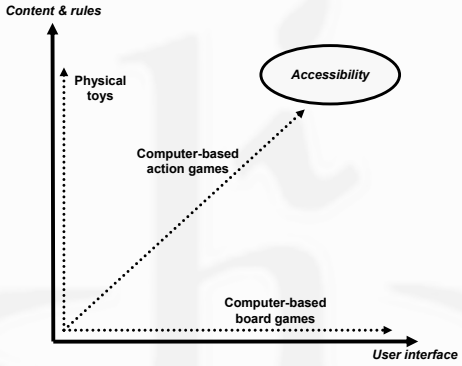
Play UA-Chess

- You can play UA-Chess online at:
  - www.ics.forth.gr/hci/ua-games/ua-chess

Action games

- Constitute a real challenge for Universal Access
- Have highly dynamic content comprising many different moving objects with alternative characteristics that appear and disappear
  - e.g., the player's character / ship, enemies, bullets, balls, bonuses
- Require complex controls
- Are based on reflex-based reacting
- The way that two players with different disabilities can cooperatively play the same action game is currently an open research issue

Board vs. Action Games

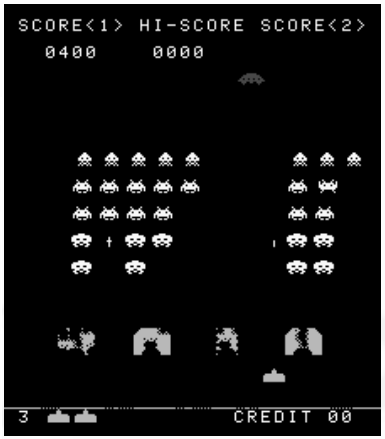


- A basic design differentiation between universally accessible board and action games is the "degrees of freedom" along which the game can be modified in order to become accessible

Developing a "Simple" Action UA-Game

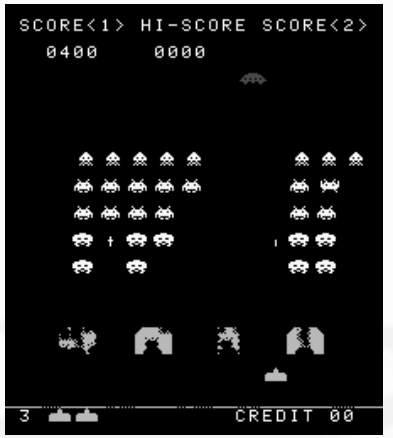
- A step by step example of creating a remake of the original Space Invaders© game by Taito® that is Universally Accessible

A simple action game?



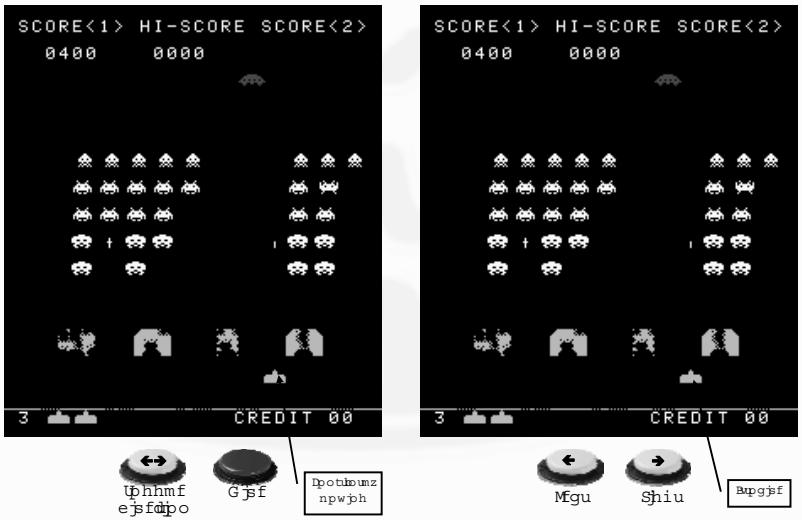
Tqkdf#Fowhefst^Jbjp^*

Using 3 switches?



Mfgu Sjiu Gjsf

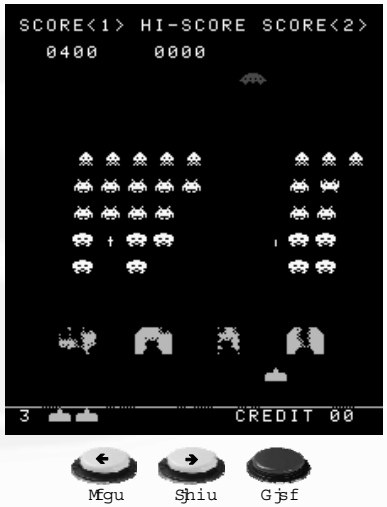
Using 2 switches?



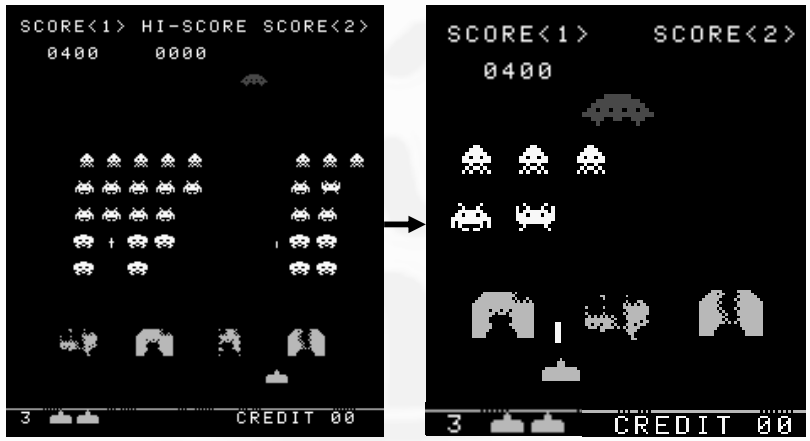
Using 1 switch?

Using 3 switches + the user cannot react quickly

- Adjust
  - the ship's speed
    - + the bullets' speed
  - the aliens' speed
    - horizontal & vertical
  - if / how often they fire
    - + the bullets' speed
  - aliens' spacing & layout
  - mothership speed



The player has low vision?

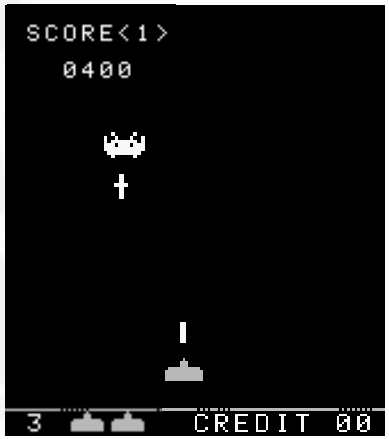


The player is blind? (1/3)

- Simplify the game
  - Alien moves from top to bottom
    - stereo sound (left/ right) which attenuates with distance
    - does not shoot
  - Player moves left / right in discrete positions
  - The player has to move below the alien and shoot it before it reaches the ground

The player is blind? (2/3)

- Making the game harder
  - Player moves freely left / right
  - Alien moves left / right
    - stereo sound (left/ right)
  - Alien drops a bomb
    - stereo sound (left/ right) which attenuates with distance



The player is blind? (3/3)

- More options
  - Several aliens & of different type
  - It is equipped with a radar that notifies when directly under alien / bomb
  - Sound cues when reaching left / right end of screen
  - Score, lives & level are read

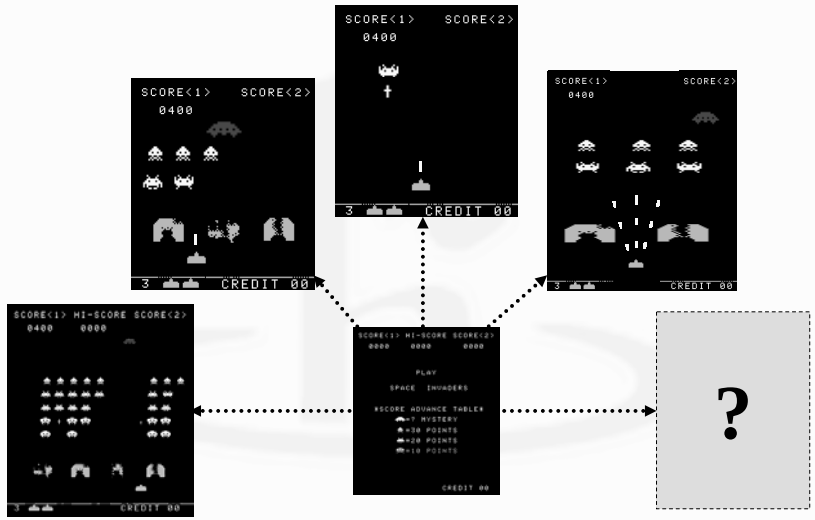
The game is too difficult for the player?

- Adjust
  - the aliens number
  - the ship's speed
  - firepower
  - if aliens move
    - their speed
  - if / how often they fire
    - + the bullets' speed
  - enlarge shields
    - allow the ship's bullets to pass through

If the game is played on a PC…

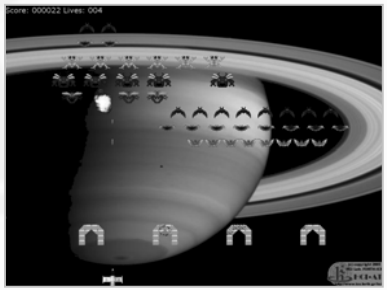
- How would the user access the game menu or pause the game?
  - If there is no restriction on the keys/switches?
    - Easy: Could use an extra key/switch
  - If only 2 or 3 keys/switches can be used?
    - Could use a combination of key presses
  - If only 1 key/switch can be used?
    - (a) Wait until the game is over
    - (b) Keep the switch pressed for more than X secs

Thus, making a UA-Game…



DffhvvLqydghuv y1413

- An accessible remake of the classic Space Invaders game
- Developed by the HCI Lab of ICS-FORTH in close cooperation with the Centre for Universal Access & Assistive Technologies
  - in the context of our UA-Games Activity
- Can be concurrently played by people with different abilities & preferences, incl. people with disabilities
  - e.g., low-vision, blind & hand-motor impaired



Interacting with DffhvvLqydghuv

- Every aspect of the game's functionality is fully accessible through
  - the mouse
  - the keyboard
  - any type of switches
  - the joystick
- Non-visual (audio-based) gameplay is also supported
  - acoustic rendering of game information is provided through the use of spatial audio and of a built-in screen reader

Configurability

- Highly customizable
  - Supports the creation and use of unlimited user profiles
  - Each game parameter can be adapted both based on the player's profile and the current game level
- Multi-player games
  - Unlimited number of concurrent players
  - Each player can be using a different profile

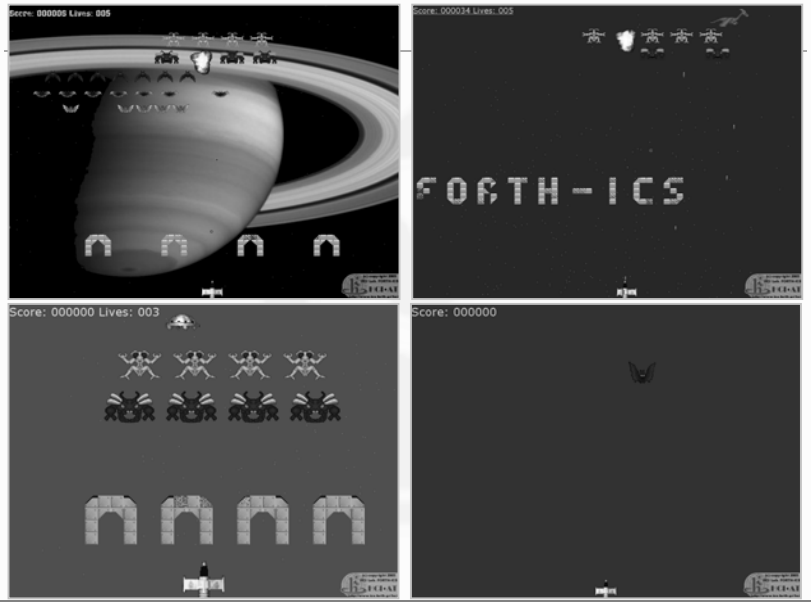
Configuration options (1/2)

Gli hqvlrq	Sdudp hwhuv
Sod|hu*v# vsdfhvkls	♦ P ryhp hqw#vshhg ♦ Exoohw#vpshhg/#dxwr0iluh#iuhtxhqf|/#li#wkh|#fdq#sdvv#wkurxjk# vklhogv, ♦ Dxwr0p rylqj#wkh#kvhu#fdq#fkdqjh#p ryhp hqw#gluhfwlrq, ♦ Q xp ehu#ri#klw#w#fdq#wdnh#ehiruh#ehlqj#ghvwur|hg ♦ Q xp ehu#ri#olyhv% ♦ Iqylqflelolw|#gxudwlrq#diwhu#w#kdv#ehhq#ghvwur|hg,
Dolhqv	♦ Z kdwh#qg#ri#dolhq#vklsv#kh#vshflilf#sod|hu#fdq#ghvwur| *Vhyhudo#dolhqv#jurxs#fdq#eh#frqiljxudeoh/#dffruglqj#wr#wkh#jurxs# fdq#kdyh#dl#gliihuhqw#frqilljxudwlrq=* ♦ Q xp ehu#ri#dlqhv#ri#dolhq#vklsv ♦ Q xp ehu#ri#dolhq#vklsv#shu#dlqh ♦ K rul}rqwdo#dqg#yhuwlfdo#dlvwdqfh#ehwz hhq#dolhq#vklsv ♦ K rul}rqwdo#dqg#yhuwlfdo#vshhg#ri#wkh#jurxs ♦ Iuhtxhqf|#ri#erp e#gurss lqj ♦ E rp e*v#vshhg ♦ Z klfk#sod|hu+v,#wklv#jurxs*v#erp ev#fdq#ghvwur|

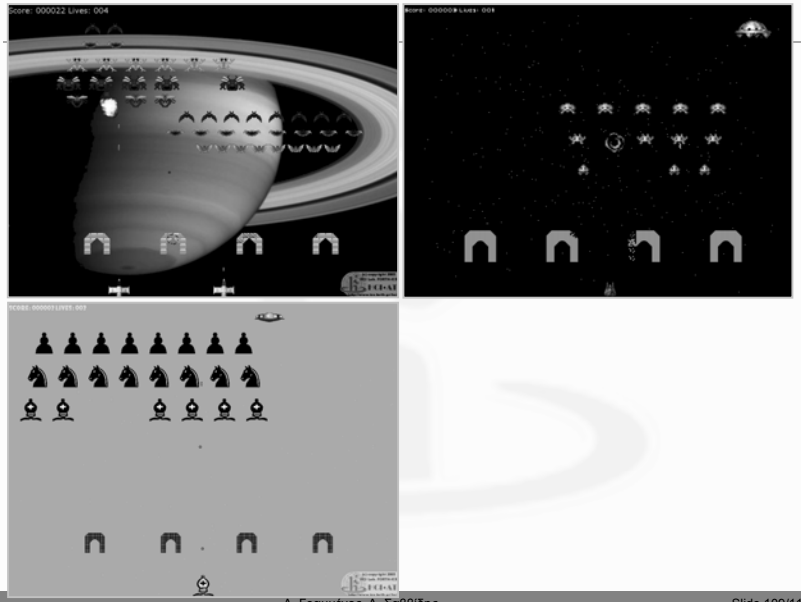
Configuration options (2/2)

Gli hqvlrq	Sdudp hwhuv
P rwkhuvkls	♦ Iuhtxhqf|#ri#dsshdudqfh ♦ Vshhg
Dqlp dwhg# judsklf# hdnp hqw#	♦ Ip djhv#dqlp dwlrq#lqp v ♦ Vrxqg#dqg#p xvlf
Vklhogv	♦ Vkdsh#dqg#ol|rxw ♦ Q xp ehu#ri#klw#wkh|#fdq#wdnh#ehiruh#ehlqj#ghvwur|hg
Edfnjurxqg	♦ F roru 2#J udsklfv ♦ Vsdfh#wudyhoolqj#iiihfw#io|lqj#vwduv,
J hqhudo	♦ Vfuhhq#uhvroxwlrq#dqg#froru ghswk ♦ Ixoo0vfuhhq2z lqgrz hg#p rgh ♦ J dp h#frqwurov ♦ I rqwv ♦ Vshhfk ♦ Lq0jdp h#p hvvdjhv

Alternative game profiles (1/2)



Alternative game profiles (2/2)



Technical info

- Runs on Windows & GNU/Linux
- Developed in C++ also using the following 3rd party tools:
  - SDL
    - a low level, cross-platform, graphics and input library. Used for drawing the graphics on the screen and getting input from the interaction devices supported by the game
  - OpenAL
    - a cross-platform 3D sound library. Used for the reproduction of sound effects, synthesized speech and music
  - Festival Lite (Flite)
    - a cross-platform runtime speech synthesis engine. Used for synthesizing speech from the textual messages and objects that appear on the screen
  - Freetype
    - a font engine for true-type font rendering. Used for rendering the textual messages and objects that appear on the screen
  - Ogg Vorbis
    - an open, patent-free, professional audio encoding, decoding and streaming technology. Libvorbis is used for the decoding of ogg music files.

Download

- You can download Access Invaders for Windows & GNU/Linux from:
  - www.ics.forth.gr/hci/ua-games/access-invaders
- Detailed user manual available, including instructions of how you can edit the current & create new game configurations

Conclusions

Creating UA-Games requirements (1/2)

- Designing for context independence
  - at an abstract level without considering specific interaction modalities, metaphors, techniques or devices and separating the content and the related mechanics from the way that these can be accessed by, and presented to, the user
- Mapping abstract design elements to coherent, usable and accessible interaction designs based on the users' individual characteristics
- Creating user interfaces that can support alternative interaction methods and modalities that can co-exist and co-operate
- Creating user interfaces that are able to adapt to alternative user profiles
  - i.e., sets of preferences, requirements and needs, and contexts of use

Creating UA-Games requirements (2/2)

- Inclusive and participative design
  - considering the broadest possible population during design and have representatives from as many categories as possible participating and providing input to all the development phases
- Designing based on incomplete knowledge
  - as games can target highly diverse audiences
- Open and extensible interaction design
  - so that, later on, it will be still possible to expand the design to cater for more user categories and contexts of use
- Designing for non-typical user groups
  - which may have nothing in common with the designer

A clarification

- When referring to games that are universally accessible, it is meant that these games can be played by <u>all people who can potentially play them</u> but may currently be restrained from it due to design flaws; not by all the people in the world
- It is obvious that there will always be games that
  - due to their intrinsic characteristics, cannot be made accessible to a range of people
    - ✦e.g., complex strategy games for the cognitive disabled
  - when made accessible may have no meaning or interest for those people
    - ✦e.g., a "find the song title from listening to a melody" game for a deaf

Benefits of UA-Games

- They strongly cater for the needs and actively support the right of all people for social interaction and play
  - irrespective of their individual differences
  - ➡ thus providing a steppingstone towards a more inclusive (and fun!) Information Society
- ◆ Furthermore, this approach has the potential to render universally accessible several "physical" games that in their original form are not (concurrently) accessible to several groups of people with diverse disabilities